

Satellite Communication

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PART A(2 Mark Questions)

1.What are the different applications of satellite systems?

- *Largest International System(Intel sat)
- *Domestic sat system in united states(Dom sat)
- *U.S National Oceanography Atmospheric Administration (NOAA)

2.Mention the different services of satellite systems.

- *Fixed satellite services
- *Broadcasting satellite services
- *Mobile satellite services
- *Navigational satellite services
- *Meteorological satellite services.

3.Define Polar-orbiting Satellites.

Polar orbiting Satellites orbit the earth in such a way as to cover the north & south polar regions.

4.State kepler's first law.

It states that the path followed by the satellite around the primary will be an ellipse. An ellipse has two focal points F1 & F2. The center of mass of the two body system, termed the barycenter is always centered on one of the foci.

$$E = \sqrt{a^2 - b^2}/a$$

5.State Kepler's second law.

It states that for equal time intervals, the satellite will sweep out equal areas in its orbital plane, focused at the barycenter.

6. State kepler's third law.

It states that the square of the periodic time of orbit is perpendicular to the cube of the mean distance between the two bodies.

$$a^3 = \mu/n^2$$

7.Define apogee & perigee.

- *The point farthest from the earth is known as apogee.
- *The point closest from the earth is known as perigee.

8.What is line of apsides?

The line joining the perigee & apogee through the center of the earth.

9.Define ascending & descending node.

The point where the orbit crosses the equatorial plane going from South North.

The point where the orbit crosses the equatorial plane going from South to North.

10.Define inclination.

The angle between the orbital plane & the earth's equatorial plane. It is measured at the ascending node from the equator to the orbit going from east to north.

11.Define mean anomaly & true anomaly .

Mean anomaly: It gives an average value of the angular position of the satellite with reference to the perigee.

True anomaly : It is the angle from perigee to the satellite position ,measured at the earth's center.

12. Mention the apogee & perigee height.

$$R_a = a(1+e)$$

$$R_p = a(1-e)$$

$$H_a = R_a - R_p$$

$$H_p = R_p - R_p$$

13. Define Universal time.

It is the time used for all civil time keeping purposes & it is the time reference which is broadcast by the national bureau of standards as a standard for setting clocks.

$$UT \text{ day} = 1/24(\text{hours} + \text{minutes}/60 + \text{seconds}/3600)$$

$$UT^0 = 360 \times UT \text{ day}.$$

14. Mention the julian dates.

$$JD = JD_{010} + \text{day number} + U_{\text{day}}$$

15. what is sidereal time?

Sidereal time is time measured relative to the fixed stars. It will be seen that one complete rotation sidereal time relative to the sun .This is because the earth moves in its orbit around the sun.

16. Define Sidereal day.

It is defined as one complete rotation of the earth relative to the fixed stars. It is measured as $23^h 56^m 04^s$ mean solar time.

17. Define Greenwich hour angle(GHA).

The angular distance from the I axis to the Greenwich meridian is measured directly as Greenwich sidereal time ,also known as the Greenwich hour angle.

18. Write the formula for GST.

$$GST = 99.6910 + 36000.7689Xt + 0.0004Xt^2 + 2 \times UT \text{ deg}$$

19. Define geocentric latitude.

$$\text{As a point of interest for zero height, the angle } \Psi_e (h=0) = (1-Ee^2)\tan\lambda E$$

20. what are the difference between the geodetic & geocentric latitudes?

The latitudes reaches a maximum at a geocentric latitude of 45deg, when the geodetic latitude is 45.192deg.

21. What is meant by azimuth angle?

It is defined as the angle produced by intersection of local horizontal plane & the plane passing through the earth station ,the satellite & center of earth.

22. What are the conditions of location of the earth station & subsatellite point of the Azimuth angle?

For ES in northern hemisphere:

$$A = 180\text{deg} - A' \text{ (ES west of satellite)}$$

$$A = 180\text{deg} + A' \text{ (ES east of satellite)}$$

For ES in southern hemisphere:

$$A = A' \text{ (ES west of satellite)}$$

$$A = 360 - A' \text{ (ES east of satellite)}$$

$$A' = \tan^{-1}(\tan(\theta_s - \theta_l) / \sin\theta_l).$$

23. Write short notes on attitude control system.

It is the system that achieves & maintains the required attitudes. The main functions of attitude control system include maintaining accurate satellite position throughout the life span of the system.

24. What is an polar antenna?

A single actuator is used which moves the antenna in a circular arc ie known as polar mount antenna.

25. What is declination?

The angle of tilt is often referred to as the declination which must not be confused with the magnetic declination used in correcting compass readings.

26. Define the terms in Eclipse.

During equinox periods, the earth the sun & the satellite are in alignment with the result that earth's shadow eclipses the satellite & the sunlight fails to reach the satellite solar cells. The eclipse effect is noticeable for periods of about four weeks & the maximum daily eclipse duration is about 1.20 hours.

27. What is meant by payload?

The payload refers to the equipment used to provide the service for which the satellite has been launched.

28. What is meant by transponder?

In a communication satellite, the equipment which provides the connecting link between the satellite's transmit & receive antennas is referred to as the transponder.

29. Write short notes on station keeping.

It is the process of maintenance of satellite's attitude against different factors that can cause drift with time. Satellites need to have their orbits adjusted from time to time because the satellite initially placed in the correct orbit, natural forces induce a progressive drift.

30. What is meant by Pitch angle?

Movement of a spacecraft about an axis which is perpendicular to its longitudinal axis. It is the deg of elevation or depression.

31. What is a propellant?

A solid or liquid substance burnt in a rocket for the purpose of producing thrust.

32. What is a Yaw?

Yaw is the rotation of a vehicle about its vertical axis.

33. What is a Zero 'g'?

Zero 'g' is a state when the gravitational attraction is opposed by equal & opposite inertial forces & the body experiences no mechanical stress.

34. Describe the spin stabilized satellites.

In a spin stabilized satellite, the body of the satellite spins at about 30 to 100 rpm about the axis perpendicular to the orbital plane. The satellites are normally dual spin satellites with a spinning section & a despun section on which antennas are mounted. These are kept stationary w.r. to earth by counter rotating the despun section.

35. What is meant by frequency reuse?

The carrier with opposite senses of polarization may overlap in frequency this technique is known as frequency reuse.

36. What is meant by spot beam antenna?

A beam generated by a communication satellite antenna of sufficient size that the angular spread of sufficient size that the angular spread of the energy in the beam is very small with the result that a region that is only a few hundred km in diameter is illuminated on earth.

37. What is an TWT?

The TWTs are widely used in transponder to provide the final output power required to the transducer & its power supplies.

38. What is meant by Intermodulation distortion?

The AM/PM conversion is then a complicated function of carrier amplitudes, but in addition, the nonlinear transfer characteristic introduces a more serious form of distortion known as intermodulation distortion.

39. Define input backoff.

In order to reduce the intermodulation distortion, the operating point of the TWT must be shifted closer to the linear portion of the curve, the reduction in input power being referred to as i/p backoff.

40. Define diplexer.

The transmit & receive signals are separated in a device known as diplexer

41. What is an OMT?

The polarization separation takes place in a device known as an orthomode transducer.

42. What is an polarization interleaving?

Overlap occurs between channels, but these are alternating polarized left hand circular & right hand circular to reduce interference to acceptable levels. This is referred to as polarization interleaving.

43. What is an SCPC?

In a time slot circuit, a transponder channel (36 MHz) may be occupied by a no. of single carriers, each associated with its own voice circuit.

44. Define S/N ratio.

The S/N introduced in the preceding section is used to refer to the ratio of signal power to noise power at the receiver output. This ratio is sometimes referred to as the post detector.

45. What is noise weighting?

Improve the post detection signal to noise ratio is referred to as noise weighting.

46. What is an EIRP?

It is a measure of radiated or transmitted power of an antenna. It can be computed from the antenna gain & the power fed to the antenna input.

47. Write the equations of losses for clear sky conditions.

$$\text{Losses} = (\text{FSL}) + (\text{RFL}) + (\text{AML}) + (\text{AA}) + (\text{PL})$$

48. What is an noise power spectral density?

Noise power per unit BW is termed the NPS density.

$$N_0 = P_N / B_N = k T N \text{ joules}$$

49. What is an Intermodulation noise?

Intermodulation distortion in high power amplifier can result in signal products which appear as noise & in fact is referred to as Intermodulation noise.

50. What are the types of antenna losses?

*sky noise

*Antenna losses

51. What is an antenna loss?

It is added to noise received as radiation & the total antenna noise temperature is the sum of the equivalent noise temperature of all these sources.

52. Define sky noise.

It is a term used to describe the microwave radiation which is present throughout the universe & which appears to originate from matter in any form, at finite temperature.

53. Define noise factor.

An alternative way of representing amplifier noise is by means of its noise factor. In defining the NF of an amplifier, denoted by F , is usually taken as 290K

$$N_{0,out} = F T_0$$

54. What is an absorptive n/w?

It is one which contains resistive elements. These introduce losses by absorbing energy from the signal & converting it to heat. Resistive attenuators, transmission lines & waveguides are all examples of absorptive networks.

55. Write the equation of system noise factor.

$$T_S = T_{ant} + T_e [1 + (L-1) T_0 / G + L(F-1) T_0 / G]$$

56. Define saturation flux density.

The flux density required at the receiving antenna to produce saturation of TWTA is termed the saturation flux density.

57. A satellite downlink at 12GHz operates with a transmit power of 6W & an antenna gain of 48.2dB. Calculate the EIRP in DbW.

$$\begin{aligned} \text{EIRP} &= 10 \log 6 + 48.2 \\ &= 56 \text{ DbW} \end{aligned}$$

58. Calculate the gain of a 3m paraboloidal antenna operating at a frequency of 12GHz. Assume an aperture efficiency of 0.5.

$$\begin{aligned} G &= 10 \log 78168 \\ &= 48.9 \text{ Db} \end{aligned}$$

59. The range between a ground station & a satellite is 42000km. Calculate the free space loss at a frequency of 6GHz.

$$\begin{aligned} (FSL) &= 32.4 + 20 \log 42000 + 20 \log 6000 \\ &= 200.4 \text{ Db} \end{aligned}$$

60. An antenna has a noise temperature of 35K & is matched into a receiver which has a noise temp of 100K. Calculate the noise power density & the noise power for a BW of 36MHz.

$$\begin{aligned} N_0 &= (35 + 100) \times 1.38 \times 10^{-23} \\ &= 1.86 \times 10^{-21} \text{ J} \\ P_N &= 1.86 \times 10^{-21} \times 36 \times 10^6 \\ &= 0.067 \text{ PW} \end{aligned}$$

61. What is a single mode of operation?

A transponder channel aboard a satellite may be fully loaded by a single transmission from an earth station. This is referred to as a single access mode of operation.

62. What are the methods of multiple access techniques?

FDMA (Frequency division multiple techniques)
TDMA (Time division multiple techniques)

63. What is in CDMA? & its types?

In this method each signal is associated with a particular code that is used to spread the signal in frequency & or time.

*Spread spectrum multiple access

*Pulse address multiple access

64. What is a thin route service?

SCPC systems are widely used on lightly loaded routes, this type of service being referred to as a thin route service.

65. What is an important feature of Intelsat SCPC system?

The system is that each channel is voice activated. This means that on a two way telephone conversation only one carrier is operative at any one time.

66. What is an TDMA? What are the Advantages?

Only one carrier uses the transponder at any one time, & therefore intermodulation products, which results from the nonlinear amplification of multiple carriers are absent.

Merits:

The transponder traveling wave tube can be operated at maximum power o/p or saturation.

67. What is preamble?

Certain time slots at the beginning of each burst are used to carry timing & synchronizing information. These time slots collectively are referred to as preamble.

68. Define guard time.

It is necessary to have a gap between bursts to prevent the bursts from overlapping. The guard time will vary from burst to burst depending on the accuracy with which the various bursts can be positioned within each frame.

69. What is meant by decoding quenching?

In certain phase detection systems the phase detector must be allowed time to recover from one burst before the next burst is received by it. This is known as decoding quenching.

70. What is meant by direct closed loop feedback?

The timing positions are reckoned from the last bit of the unique word in the preamble. The loop method is also known as direct closed loop feedback.

71. What is meant by feedback closed loop control?

The synchronization information is transmitted back to an earth station from a distant, that is termed feedback closed loop control.

72. Define frame efficiency.

It is a measure of the fraction of frame time used for the transmission of traffic. Frame efficiency is defined as

$\eta_f = \text{traffic bits} / \text{total bits}$

$\eta_f = 1 - \text{overhead bits} / \text{total bits}$

73. What is meant by telephone load activity factor?

The fraction of time a transmission channel is active is known as the telephone load activity factor.

74. What is meant by digital speech interpolation?

The point is that for a significant fraction of the time the channel is available for other transmissions, & advantage is taken of this in a form of demand assignment known as digital speech interpolation.

75. What are the types of digital speech interpolation?

- Digital time assignment speech interpolation
- Speech predictive encoded communications

76. What is meant by freeze out?

It has assumed that a free satellite channel will be found for any incoming speech spurt, but of course there is a finite probability that all channels will be occupied & the speech spurt lost. Losing a speech spurt in this manner is referred to as freeze out.

77. What is DSI?

The DSI gain is the ratio of the number of terrestrial channels to number of satellite channels. It depends on the number of satellite channels provided as well the design objectives stated above.

78. What are the advantage of SPEC method over DSI method?

The SPEC method over DSI method is that freeze out does not occur during overload conditions.

79. What is ratio of bit rate IF bandwidth?

$$R_b/B_{IF} = m/(1+\rho)$$

'm' is the roll off factor

m=1 for BPSK

M=2 for QPSK.

80. What are the demerits of conventional approach method?

- *Excessive size & weight
- *Power consumption.

81. Define space division multiplexing.

The satellites in Geostationary orbit can be achieved through the use of antenna spot beams. The use of spot beam is also known as space division multiplexing.

82. Define satellite switched TDMA?

Space division multiplexing can be realized by switching the antenna interconnections in synchronism with the TDMA frame rate, this being known as satellite switched TDMA.

83. What is SS/TDMA?

A modern pattern is a repetitive sequence of satellite switch modes, also referred to as SS/TDMA.

84. What is processing gain?

The jamming or interference signal energy is reduced by a factor known as the processing gain.

85. What are the applications of Radarsat?

- *Shipping & fisheries
- *Ocean feature mapping
- *Oil pollution monitoring
- *Iceberg detection
- *Crop monitoring

86. What is ECEF?

The geocentric equatorial coordinate system is used with the GPS system, where it is called the earth centered, earth fixed coordinate system.

87. What is dilution of precision?

Position calculations involve range differences, & where the ranges are nearly equal, any error is greatly magnified in the difference. This effect, brought about as known as a result of the satellite geometry is known as dilution of precision.

89. What is PDOP?

With the GPS system, dilution of position is taken into account through a factor known as the position dilution of precision.

90. What is burst code word?

It is a binary word, a copy of which is stored at each earth station.

91. Define SIC.

It identifies the transmitting station.

92. What is a start of receiving frame?

At any given traffic station, detection of the unique word in the reference burst signals the start of receiving frame.

93. What is meant by burst position acquisition & burst position synchronization?

A station just entering, or reentering after a long delay to acquire its correct slot position.

94. What is a single access?

A transponder channel aboard a satellite may be fully loaded by a single transmission from earth station.

95. What is a multiple access technique?

A transponder to be loaded by a number of carriers. These may originate from a number of earth stations may transmit one or more of the carriers. This mode of operation known as multiple access technique.

96. What are the two types of multiple access technique?

- * FDMA

- * TDMA

97. What is meant by frequency reuse?

The satellite as a whole to be accessed by earth stations widely separated geographically but transmitting on the same frequency i.e., known as frequency reuse.

98. What is meant by space division multiple access?

The satellite as a whole to be accessed by earth stations widely separated geographically but transmitting on the same frequency i.e., known as frequency reuse. This method of access known as space division multiple access.

99. Write the equations of C/N ratio.

$$C/N_0 = (EIRP) + (G/T) - \text{LOSSES} - (K) \text{ dBHz.}$$

100. What is an error detecting code?

A code which allows for the detection of errors is termed an error detecting code.

PART B(16 Marks Questions)

1. Describe the terms of Earth orbiting satellites.

***Apogee:** The point farthest from earth.

***Perigee:** The point closest approach to earth

***Ascending node:** The point where the orbit crosses the equatorial plane going from south to north.

***Descending node:** The point where the orbit crosses the equatorial plane going from north to south.

***Line of nodes:** The line joining the ascending & descending node through the center of the earth.

***Line of apsides:** The line joining the perigee & apogee through the center of the earth.

***Inclination:** The angle between the orbital plane & the earth's equatorial plane.

***Prograde orbit:** An orbit in which the satellite moves in the same direction as the earth's rotation.

***Retrograde orbit:** An orbit in which the satellite moves in a direction counter to the earth's rotation.

***Argument of perigee:** The angle from ascending node to perigee, measured in the orbital plane at the earth's center in the direction of satellite motion.

2. Explain the orbital plane. Draw it neat sketch

i) **Diagram:**

ii) **Explanation:**

*In the orbital plane, the position vector 'r' & the velocity vector 'v' specify the motion of satellite.

$$R = a(1 - e^2) / (1 + e \cos v)$$

*Mean anomaly M at time t is found

$$M = n(t - T)$$

$$V = M + 2e \sin M + 5/4 e^2 \sin 2M.$$

3. Explain the Orbital perturbations.

Explanation:

*Effect of non-spherical earth

*Atmospheric drag

*Inclined orbits

*Calendars

*Universal time

*Julian dates

*Sidereal time

4. Explain the geocentric equatorial & top centric co-ordinate system.

- **Diagram:**

- **Explanation:**

5. Explain the sub satellite point

i) **Diagram**

ii) **Explanation:**

6. Explain the look angle determination. Draw it neat sketch.

i) **Diagram:**

ii) **Explanation:**

7. Explain the polar mount antenna. Draw it neat sketch.

i) **Diagram:**

ii) **Explanation:**

8. Explain the limits of visibility & sun transit outage.

i) **Diagram:**

ii) **Explanation:**

9. Explain the attitude control. Draw it neat sketch.

i) **Diagram:**

ii) **Explanation:**

10. Explain the Transponders system.

i) **Diagram:**

ii) **Explanation:**

*Transponder

*Wideband receiver

11. Draw the neat sketch & explain the Input Demultiplexer.

i) **Diagram:**

ii) **Explanation:**

12. Draw the neat sketch & explain the Antenna subsystem.

i) **Diagram:**

iii) **Explanation:**

13. Draw the block diagram & explain the Receive only home TV systems.

i) **Diagram:**

ii) **Explanation:**

14. Explain the indoor unit & outdoor unit.

i) **Diagram:**

ii) **Explanation:**

15. Draw the block diagram & explain the Master antenna TV system.

i) **Diagram:**

ii) **Explanation:**

*Community antenna TV system

*Transmit receive earth stations.

16. Explain the EIRP & Transmission losses.

*EIRP = $G P_s$

*EIRP is often expressed in db is given by

$EIRP = (P_s) + (G) \text{ Dbw.}$

Transmission losses:

- Free space transmission
- Feeder losses
- Antenna misalignment losses
- Fixed atmospheric & ionospheric losses

17. Draw the block diagram & Explain the System noise temperature.

i) Block) Diagram

ii) Explanation:

- *System noise
- *Antenna noise
- *Amplifier noise temperature
- *Noise factor
- *Noise temperature of absorptive networks.

18. Explain the carrier to noise ratio of uplink & downlink frequency.

19. Explain the Intermodulation noise & saturation flux density.

20. Explain the operation of FDMA system with relevant diagram.

i) Diagram

ii) Explanation

- *Preassigned FDMA
- *Demand assigned FDMA

21. Explain the operation of FDMA down link analysis.

i) Diagram

ii) Explanation

22. Draw the Frame format & explain the operation of TDMA system.

i) Diagram

ii) Explanation

Reference burst

- *Guard time
- *Carrier & bit timing recovery
- *Burst code word
- *Station identification code
- *TTY
- *Service channel

23. Draw the data format & explain the Unique word detection.

i) Diagram

ii) Explanation

- *Miss probability
- *False detection probability

24. Explain the Satellite switched TDMA & CDMA. Draw the neat sketch.

i) Diagram

ii) Explanation

25. Explain the Radar sat & MSAT. Mention the applications.